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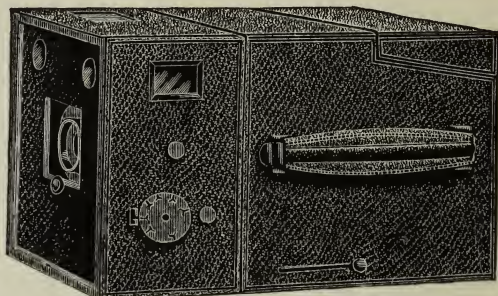
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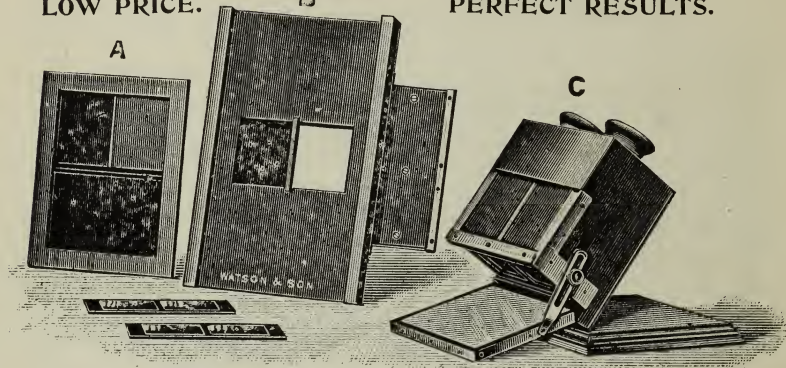
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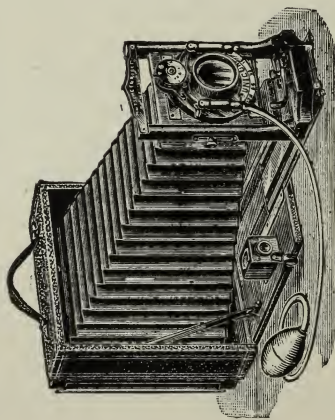
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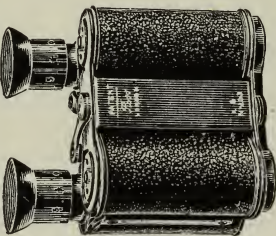
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COLOUR PHOTOGRAPHY

*A PRACTICAL TREATISE FOR
AMATEURS*

BY
A. E. SMITH

WITH ILLUSTRATIONS

[THE AMATEUR PHOTOGRAPHER LIBRARY, No. 21]

LONDON
HAZELL, WATSON, & VINEY, LD.
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1900

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COLOUR PHOTOGRAPHY.

CHAPTER I.

INTRODUCTORY.

COLOUR photography is ever in the air. Scarcely a week is allowed to pass without some allusion to this topic in one or other of the photographic journals. Yet how small a proportion of the vast army of photographers possess even the slightest theoretical knowledge of the subject! Hundreds of amateurs, aye, and professionals too, who have spent, perhaps, the greater portion of their existence at photography, men capable of turning out the best of results in monochrome, look upon colour work as a branch of photography beset with such overwhelming difficulties as to deter them from giving to it even a passing thought or consideration. Jogging along in the same old groove, heedless of modern progress and advancement in the hobby or profession of their choice, they never once stop to ask themselves the

simple question—Is it possible for *me* to produce a photograph in colour?

This is no imaginary picture, for the writer well remembers meeting a provincial photographer who, though he had heard a great deal about various methods of colour photography, had never seen an Ives' "Krömsköp." Delighted with the pictures shown him in the instrument, and the simplicity of the process, it was not long before he was hard at work on the contents of his greenhouse.

There can be no possible doubt whatever that there must exist some as yet unexplained causes for this general display of apathy and lack of interest in a subject which should be expected to excite the enthusiasm of every photographer, and I venture to think that it is not a very difficult task to locate them. Firstly, then, the lack of an up-to-date text-book, free from technicalities likely to confuse the uninitiated; secondly, the unique manner in which the subject is, from time to time, hashed up in the lay press; and last, but not least, owing to the numerous methods of tinting monochrome prints with aniline colours, or of changing the colour of the image by local application of various chemicals, which are too often put forward under the title of colour photography, or photography in natural colours. One

such process has before now been ably criticised in the columns of *The Amateur Photographer* under the befitting heading, "The Jackdaw in Peacock's Feathers." But still they come with unblushing impudence, heralded in under the same false banner, with no better object in view than the reaping of a golden harvest at the expense of a credulous public. These, then, are possibly some of the reasons which account for the comparatively small number of colour workers.

No matter in what branch it is pursued, monochrome photography is a delightful hobby, and there can be very few who, fortunate in the possession of a well-stocked garden or conservatory, cannot recall many a pleasant half-hour spent in the tasteful arrangement and lighting of fruit or cut flowers, preparatory to uncovering the lens. Yet how infinitely greater would have been the pleasure derived could but the additional charm of contrasting and grouping their colours have been taken into consideration !

At the outset, be it understood, this little book makes no pretence of dealing with the subject of photography in natural colours, but rather the reproduction, or imitation, of colour by the process oftentimes described as heliochromy, or photochromy, but more commonly known as three-colour photography.

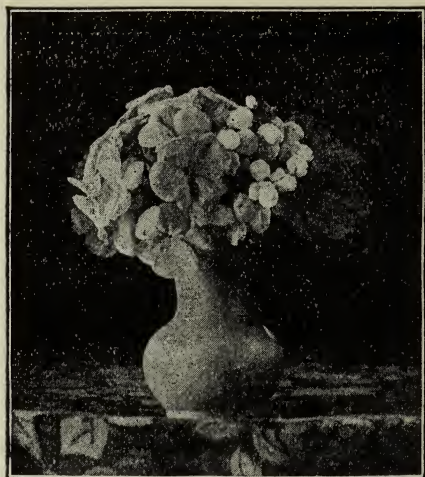
As, possibly, there are many who would like to try their 'prentice hands at this fascinating branch of photography, it is the intention of the writer to put the matter before them in a clear and comprehensive manner, avoiding, as far as possible, all technicalities, in the hope that some of those who have dismissed the subject from their thoughts under the impression that it is beyond the scope of their abilities will be tempted to put one or other of the methods to be described to a practical test.

CHAPTER II.

THE THEORY OF COLOUR PHOTOGRAPHY SIMPLY EXPLAINED.

LET me, then, first of all explain the theory of colour photography. Every reader knows how, by means of a spectroscope, the composition of white light may be studied. How, on looking through this instrument, a continuous band of colour is presented to the eye, commencing with red, through orange, yellow, green, blue, until finally violet is reached. Every one, too, has heard of the theory propounded by Dr. Thomas Young and Professor Helmholtz, namely, that all these colours may be formed from three fundamental, or primary, coloured lights—a red, green, and blue-violet—and how Clerk-Maxwell and, in recent years, Mr. F. E. Ives have conclusively demonstrated the correctness of this theory.

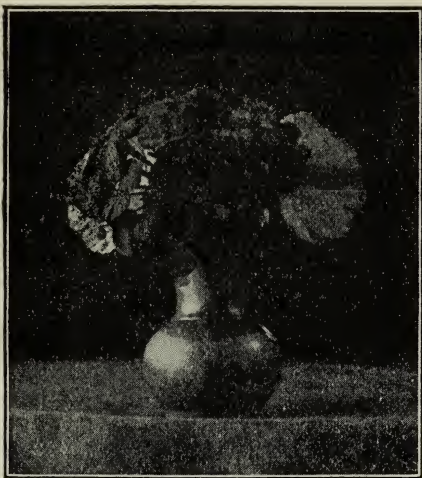
If, therefore, we can match in this way any colour in the solar spectrum, it stands to reason that any of the numerous tints to be found in Nature may be counterfeited in a similar manner.



No. 1.—Red.



No. 2.—Green.



No. 3.—Blue.

And not only can they be imitated by the blending of coloured lights, but also by mixing, or superimposing, the three primary, or pigmentary, colours of the artist—red, yellow, and blue. The exact tints may be readily ascertained in the following manner:—To find the primary blue, mix the primary coloured lights, green and blue-violet, when a greenish or cyan-blue will result; to ascertain the yellow, blend the primary lights, red and green; and to find the primary pigment colour, red, combine the primary lights, red and blue-violet, when they will be found to produce a magenta-pink, or a tint somewhat similar in colour to crimson lake. These colours are some-

times spoken of as complementary spectrum colours. Magenta-pink is complementary to the green because these two lights would, if mixed, produce white. Yellow is complementary to the blue-violet because they, together, make white, and cyan-blue for the reason that, with the fundamental red, they, too, form a white light.

We have, therefore, two sets of colours in use for the production of colour photographs by the three-colour process, the red, green, and blue-violet being adopted when we obtain our results by combining the primary, or fundamental, lights, and the three primary colours of the artist—magenta-pink, lemon-yellow, and cyan-blue—when it is desired to produce a positive picture on paper, or a transparency for the lantern, the Joly process alone excepted, the colours in this case being formed from red, green, and blue-violet.

By referring to the illustrations on pages 10 and 11, the *modus operandi* of the two methods should be readily understood. These pictures are from negatives taken by the writer, produced entirely with inexpensive home-made apparatus, which will be subsequently described. The subject is a group of scarlet geraniums and yellow calceolaria in a terra-cotta vase, supported upon a box covered with a tablecloth, bearing a design in red upon a blue-black ground. No. 1 is a print

from the red sensation negative, No. 2 from the green, and No. 3 a positive from the blue-violet negative.

It will be noticed, upon careful comparison, that no two of these prints are alike, this dissimilarity being brought about when taking the negatives by means of three coloured screens, or light-filters, which are used in much the same way as an Ilford screen is utilised with a chromatic plate.

When the three negatives are made upon one brand of plate, as, for instance, the Cadett "Spectrum," or a Lumière "Panchromatic," the colours of the screens are respectively a red, green, and blue, of such depth of colour as to permit only those colours to pass which are desired to have an actinic effect upon the plate. In this way three negatives of varying densities are obtained.

To better appreciate the effect of these screens, or light-filters, take a cloth-bound copy of Whitaker's Almanack and view it through the ruby glass of a dark-room lantern. While the red portion of the binding appears to be considerably lighter in colour the green covers have turned apparently black. This little experiment will show that the red screen will permit the red portion of the cover to pass through and be recorded by the sensitive plate, while to the green backs,

which are not required to take an active part in the red sensation negative, the door is closed, their shape and form being, to all intents and purposes, represented by clear glass in the resulting negative. In a similar way, the green and blue-violet screens select only those colours which are required to reach the plate during the exposures for the green and blue-violet sensation negatives.

To return to our positives. The writer was once told that these looked just like any ordinary photographs, except that one was, perhaps, a little darker in places than another, and doubtless many who see them reproduced here will make a similar remark. But it is owing to this little dissimilarity that it becomes possible to reproduce the original subject in colour, either by the blending of the three primary, or fundamental, lights, or by superimposing the primary colours of the artist.

We will take the latter method first. Let us imagine these three pictures to be printed in transparent pigment—No. 1 in cyan-blue, No. 2 in magenta-pink, and No. 3 in lemon-yellow—and that with these three prints we are going to build up a picture in colours, or, in other words, to produce a facsimile in colour of the original vase of flowers. How do we proceed? First of all, we will lay print No. 1 upon print No. 2, and

see what happens. We shall have magenta-pink geranium and pinky-white calceolaria. The leaf on the left being a light yellow-green, and on the light side of the picture, will be bluer in colour than the one on the right, which is of a darker hue and in shadow, while the vase and ivy pattern of the tablecloth will contain considerably more pink than blue. If we now add print No. 3 in yellow, the final and complete change of colour takes place: the vase will turn a terra-cotta colour, the leaves and flowers will assume their normal shades of green, scarlet, and yellow, the pattern of the tablecloth appearing in red upon a black ground.

Now let us look once more at our three prints, and see what part they play in the reproduction of these colours by the blending of coloured lights. In this case they will take the form of ordinary lantern transparencies on glass, and be projected upon a lantern screen by means of a triple lantern, the three slides being made to register one upon another, so as to appear as one picture. But first of all we must place in the lantern three coloured screens, representing the three primary coloured lights, red, green, and blue-violet (screens for this purpose may be obtained from the Photochromoscope Syndicate, 28, The Pavement, Clapham Common), and so adjust the light from the

three limes that when the three coloured lights are blended together, the lantern sheet appears quite white. It is now possible to practically test the composition of white light, and to find the tints of the three primary pigmentary colours of the artist by the simple experiment of placing a finger in front of one of the lantern lenses. If it be the blue-violet lantern, a yellow silhouette of your finger will appear upon the screen, the blue-violet being cut out, leaving only the mixed red and green lights where the shadow falls. Place it in front of the red lantern, and the shadow will appear a cyan-blue. Stop out the green, and it will appear a magenta-pink.

This, then, is exactly what our monochrome lantern slides are going to do when they are placed in front of their respective screens in the lantern carriers. They will stop out all coloured lights, excepting such proportions and quantities as are necessary to reproduce the colours of the original. For example, to imitate our red geraniums, we require nearly all red light, in various quantities, that is to say, more light in the high lights and less in the shadows. Reference to positive transparency No. 1 from the red sensation negative will make it clear how this colour is to be allowed to reach the sheet ; while in like manner positives Nos. 2 and 3 will explain how the green and blue-

violet lights will be kept back. To reproduce the yellow calceolaria both red and green light is required to reach the screen, as these together form yellow. Further comparison of transparencies Nos. 1 and 2 will show these flowers to be represented by comparatively clear glass, thus allowing the red and green lights to pass ; while in No. 3 they appear nearly opaque, consequently the blue-violet light is prevented from taking any part in the reproduction of their colour. In this way all the original tints may be counterfeited.

Enough has been said upon the theoretical side of the subject, and I trust my attempt to make it easily understood has been successful.

CHAPTER III.

COLOUR SCREENS.

HOW TO MAKE, TEST, AND USE THEM.

Now for the practical part. What apparatus do we require? Of paramount importance is the set of screens for making our three negatives. It is essential, if the finest results are aimed at, that they should be carefully adjusted for the plate they are intended to be used with. This need not, however, trouble those to whom a little preliminary expenditure upon materials is of no moment, as a set of Carbutt's colour screens, with instructions for use, may be obtained from Penrose & Co., 8 and 8A, Upper Baker Street, Lloyd Square, London, W.C., for a guinea.

A set adjusted for use with the Cadett "Spectrum" plate may be procured from Sanger Shepherd & Co., 5, 6, and 7, Gray's Inn Passage, Red Lion Court, Holborn. This firm also supply materials for printing lantern slides in the three primary colours of the artist. From A. Lumière et

Fils, Lyons, France, or their London agents, Messrs. L. Gaumont & Co., 25, Cecil Court, W.C., screens for use with their well-known plates can be purchased, and from the Photochromoscope Syndicate, Clapham Common, a special camera back, complete with screens and dark slide, is obtainable, also an ingenious instrument called the "Krömsköp," the invention of Mr. F. E. Ives, whereby the monochrome transparencies may be viewed in colours by the blending of the primary coloured lights, using day or artificial light as the illuminant. A simple triple lantern for projecting the colours upon the screen, in which the light from one lime is made to simultaneously illuminate the three lanterns, is also procurable. These instruments are very low in price, yet beautifully made and scientifically perfect.

Colour-filters for use in conjunction with the "Kromaz," a viewing instrument of somewhat similar construction to the "Krömsköp," are procurable from Messrs. Watson & Sons, 313, High Holborn. Particulars of this instrument, the "Krömsköp," and the "Melanochromoscope," a combined apparatus for taking the three negatives and viewing the positives in colours, will be found in Chapter VII.

This completes the list of materials commercially obtainable, with the exception of the ruled screens

for Dr. Joly's process (*see* Chapter VI.), and I must leave my readers to judge for themselves which method of producing pictures in colour is best adapted to their requirements, and to select their materials accordingly.

As promised in the previous chapter, I shall now detail my own methods of working, and endeavour to show how colour photography may be carried out without any additional apparatus beyond a camera-front of the simplest description, so simple that it should not be difficult for any one at all handy with plane, chisel, and fretsaw to make; but even this might be dispensed with, reducing our outfit to a set of screens, or light-filters, and the necessary materials for printing lantern slides and paper prints.

Doubtless many who contemplate adding colour work to their photographic *répertoire* will prefer to purchase their screens from one or another of the sources previously mentioned. Still there may be others, equally enthusiastic, to whom the outlay of a few sovereigns is a matter for consideration, and it is to their benefit that the concluding portion of this chapter will be devoted.

By way of a little preliminary encouragement, let me mention that all my own work has been done with a Lancaster's Extra Special camera, using Wray's R.R. lenses and home-made light-

filters, the results secured being satisfactory in the extreme—in fact, they could not be better had the screens cost half a sovereign or more each.

Now there are two ways of making our red, green, and blue-violet sensation negatives, namely, taking all three upon one brand of plate, sensitive to the whole length of the prismatic solar spectrum—that is to say, sensitive to all the colours to be found in nature, such as the Cadett “Spectrum,” and Lumière’s “Panchromatic”—the other by making them upon different brands of plates, sensitive chiefly to those colours required to act in the several negatives. In the second method the plates used are as follows:—For the red sensation negative a Lumière orthochromatic, Series B, sensitive to red and yellow; a Lumière orthochromatic, Series A, sensitive to green and yellow, for the green negative; and an ordinary, or unorthochromatic, plate, such as the Ilford ordinary, for the blue-violet sensation negative. One advantage that must recommend the latter method to the beginner is, that the plates may be developed in plenty of light, the ordinary ruby lamp being used for the green and blue-violet negatives, a green glass being substituted for the ruby in developing the red negative, Lumière’s B plate being insensitive to green. With a “Spectrum” plate hardly any light is permissible

for development. A safe light is, however, sold for this purpose ; but as it practically absorbs all the solar spectrum, little light can come through it.

The plates are, of course, exposed in the ordinary dark slides of the camera, which should preferably have three backs, in order to save time in changing the plates. The ideal method, however, is to use the Cadett "Spectrum" plate in a special camera, which permits of the three negatives being simultaneously made at one exposure, side by side, upon one plate. In this way we get our three negatives correctly exposed and evenly developed. Any movement of trees, or clouds, in a landscape is equally recorded in each negative. Though Mr. Ives has designed and used such a camera, it is not, I fear, likely to be placed upon the market, the arrangement of mirrors and prisms being too elaborate for general use. He has, however, quite recently patented another camera for taking three small negatives which should meet the requirements of amateur workers.

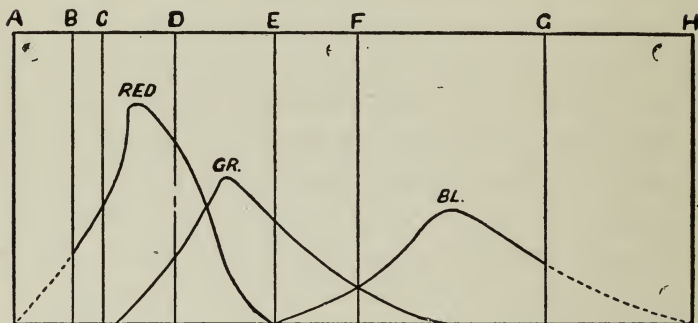
Messrs. Sanger Shepherd and Co. make an instrument which practically accomplishes the same end, the only difference being that the negatives are made upon separate plates, but of the same brand, carried in different parts of the camera, so that they can all be developed in one dish. But I am digressing from my promise in

discussing apparatus here. We are going to work on the cheap, so must be content to let landscape work severely alone, excepting in perfectly calm and still weather.

If the "Spectrum" plate be adopted, we shall require red, green, and blue-violet light-filters ; but these are not, as popularly supposed, the same as are used for viewing results in colour by blending the three primary coloured lights, but should, as far as possible, conform to the requirements laid down by the Clerk-Maxwell colour curves. To explain, supposing we desire to reproduce an object in colour by the blending of our primary lights with the aid of a triple lantern. Let us imagine it is the solar spectrum itself we wish to reproduce. What do we require to enable us to mix these coloured lights upon the lantern screen in such proportions as to imitate the original in colours? Three transparencies, or lantern slides, of such varying densities and gradations as shall stop out just that portion and quantity of the three primary lights, or fundamental spectrum colours, that are not required in forming the colours of the solar spectrum. Let us look for a moment at the diagram of the spectrum on this page. If this can be compared at the same time with a coloured chart, which may be found in almost any public library in nearly every

standard work on light, my remarks will be more easily understood.

The curved lines drawn in the form of three little hillocks indicate the Clerk-Maxwell colour mixture curves, and from them we readily learn what portions of the spectrum should be photographically recorded in our three lantern slides



Clerk-Maxwell's Colour Curves.

if we are to obtain a correct colour reproduction on the lantern sheet.

The gradation of the slide printed from the blue-violet sensation negative will, obviously, be opaque from the red at A to green at E, at which point opacity will gradually give way in the proportion indicated by following the curve to its extreme height at BL (short for blue-violet), which will be represented by clear glass, descending again, with corresponding increase in density,

until all transparency disappears at H. Similarly, with the green positive we shall find no light able to come through it until we get to the red just beyond C. Here transparency will increase in proportion to the steepness of the curve, until clear glass is reached at the summit, midway between D and E, gradually descending, with corresponding increase in opacity, until half-way between F and G, where no further green light can get through to the screen. In a similar manner the red positive should be transparent at midway between C and D, gradually increasing in density on either side until opacity is reached at A and E.

Obviously, then, to procure these transparencies we must have a set of three negatives, which shall have been made through screens, or light-filters, which allow only these portions of the spectrum to act during the exposures for their respective negatives—that is to say, the red screen should pass all colours from the red end of the spectrum to E in the green. The green filter all colours from just beyond C in the red to midway between F and G in the blue, while the blue-violet screen must transmit the colours lying between E in the green and the violet end of the spectrum.

This the screens used for viewing positives by combining the primary lights would not do, as,

being too deep in colour, they would individually cut out too much of the spectrum. The colours recorded in the negatives must, so to speak, overlap according to the proportions laid down by Clerk-Maxwell, or we shall not be able to satisfactorily reproduce our subject in colour. For instance, yellow must be equally recorded in both the red and green negatives. Reference to the illustrations on page 10 will show that the yellow *calceolaria* is comparatively transparent in both the red and green pictures, so that when they are backed up with their red and green glasses in the lantern, and projected upon the sheet, they appear yellow because the red and green lights are present in nearly equal proportions. Therefore it must be plain to every one why screens used for lantern projection cannot be used for taking the negatives.

Now to make our screens. The materials required are few and simple, comprising an ounce or two of Mawson's negative collodion (uniodised), a bottle of Higgins's photo-mounter, some paper strips, a few aniline colours, and some glass.

The glass should be what is known as "patent plate," and can be obtained from any glazier or glass merchant—excepting, possibly, in the very small country towns; but even there it could be procured to order through the local glazier.

A great deal of unnecessary fuss has been made about the necessity for using optically worked glass for colour screens ; but the writer's experience is that thin patent plate is practically optically plane on both sides, that is, each side is perfectly level and parallel ; in fact, it could not be improved (in all probability it would be spoiled) were it sent to an optician to be "worked." Still, if any prefer it so prepared, it can be procured from Penrose & Co., squares two inches by two inches costing four shillings apiece, and as six pieces are wanted for a set of screens such as we are about to make, the glass alone would cost 24s., whereas the same quantity of thin patent plate can be obtained, cut to size, for a few pence. I have paid as little as twopence for six pieces two inches by two inches.

For the colouring matter it is sufficient to purchase a few pennyworths of commercial dyes, which I have found admirably adapted to screen-making. We shall require three penny packets of Judson's green, one of violet, and a three-penny packet of "Diamond" scarlet and yellow for *cotton* ; in all, tenpennyworth of colouring matter, sufficient for a hundred or more screens, and which may be purchased at almost every chemist's and oil shop. These require to be made up in solutions as follows :—Dissolve the penny

packet of Judson's violet in one ounce of boiling water, the two packets of green in one ounce, and the third in another ounce of hot water. Of the threepenny packet of "Diamond" scarlet, about six grains to the ounce of hot water should be used, with two grains of salt to each ounce of solution. For the yellow bath a thimbleful of the powder in three or four ounces of water will be about sufficient.

We are now ready to commence our screens, which will be found a very easy task if the following instructions are closely adhered to:—

For the red screen, take a piece of the patent plate glass, and carefully clean with a little ammonia. Hold the glass on the tips of the fingers, as shown in illustration, and pour on sufficient collodion to cover the plate, as indicated by the dotted lines. With a slight movement of the wrist, the collodion should be made to flow to corner No. 1, then, following the edge of the plate, to corner No. 2, and along the top edge of the glass to No. 3, the surplus being finally poured back into the bottle from corner No. 4. With a very little practice this operation may be performed in a few seconds, and the quicker the better, as the collodion sets very quickly. Coating should be preferably done by daylight, owing to the fact that collodion is highly

inflammable. It must be kept in a glass-stoppered bottle, or it will get thick and require the addition of a little ether before it will flow easily over the plate. As soon as the glass is coated, it must be allowed to stand for a minute or so, until the collodion film has assumed a leathery appearance, when it is placed, glass side down, or standing on its edge against a bottle, in a



basin of clean water, where it should remain until all greasiness has disappeared. This is known by the water flowing freely and evenly off the film when withdrawn from the water, which it generally does after about five minutes' soaking. The plate is now immersed, collodion side uppermost, in a small porcelain dish (lantern size is convenient) containing a couple of ounces of the "Diamond" scarlet dye solution. It will require to remain in the bath for a considerable time—

possibly some hours—before a deep enough colour is arrived at. When this stage is reached, rinse slightly in clean water, or under a tap, to remove the superfluous dye, and set up to dry, which may take about ten or twelve hours, after which time the coloured film will be found to have lost its leathery appearance, and to lie quite smoothly upon the glass. Great care must be exercised to avoid touching the collodion film whilst wet, as it might easily be pulled off the glass.

Another plate is treated in a similar manner, and when dry the two are cemented together, film to film, by the application, on the point of a pocket penknife, to the edges of the glass, of a small quantity of Higgins's photo-mounter. A very little will suffice; too much would result in the screen being spoiled, as, when the two glasses are pressed together, it would spread between the films and destroy transparency. Allow half an hour for the paste to set, and then bind the two glasses firmly together with paper strips, just as you would bind up a lantern slide.

For the green screen, coat another piece of glass with collodion, and immerse in the bath containing two packets of Judson's green in one ounce of water. Rinse and dry as before. Coat a second glass with collodion and colour in the "Diamond"

yellow bath. This dye acts rather slowly, and it may be necessary to leave the glass in the solution for an hour, or longer, before the collodion film is stained a deep enough yellow. The two glasses are bound up in the same way as the red.

For the blue-violet screen, coat two pieces of the patent plate glass with collodion. Colour one in the violet solution, and the other in the bath containing one penny packet of Judson's green to the ounce of water, both being rinsed, dried, and bound up as in the case of red and green screens. This filter will be comparatively deeper in colour than the other two, and if of the right shade, will be a deep cobalt, or ultramarine, blue. Owing to the fact that collodion is highly inflammable, screen-making should invariably be conducted in daylight.

The next step is the testing of our screens to ascertain if they cut off approximately in accordance with the Clerk-Maxwell colour curves, previously described. Theoretically, this operation should be performed with a spectroscope, but, as a direct vision instrument to be anything like useful cannot be purchased for less than a guinea, I will show how to do without, and illustrate the old proverb of "necessity," etc. We cannot, however, dispense with a prism. This is a triangular piece of glass, and can be obtained from

Penrose & Co., one and half inches in length, for half a guinea. Personally, I have been rather fortunate with prisms, having some glass candlesticks resplendent in those old-fashioned triangular glass embellishments. If any of my readers have similar ones, or a glass chandelier decked

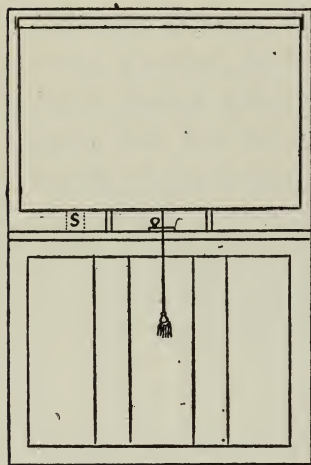


Fig. 1.

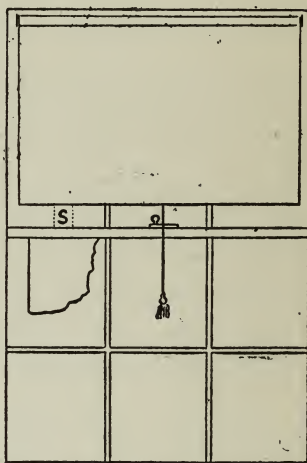


Fig. 2.

with these ornaments, they have a veritable orchard of prisms on the premises. Hook one off when you want to test your screens, and take it to the table facing a window. Draw the blind down to within an inch or an inch and a half of the window latch, as shown in Fig. 1. Raise the shutter, if you have one, until all the

bottom half of the window is covered up. If not, paste a piece of brown paper over glass to shut out the light, as shown in Fig. 2. Return to the table, and look through the prism, revolving it slowly, until you produce a beautiful solar spectrum in the space marked S, and enclosed by dotted lines in Figs. 1 and 2. This opening, by the way, must look out on to the sky, and not upon a house or a tree. In this way it is possible to get a perfect spectrum, showing every colour and tint from red to violet—in fact, no spectroscope, however costly, could give a better band of colour. The depth varies according to the width of space between the bottom of the blind and the window frame, and the distance from which it is viewed. The farther you sit back in the room the wider may be the opening. At a distance of eight feet you can get a spectrum four to five inches long. If you get too near, you lose the perfect band of colours, and see only a fringe of red and yellow on the blind, and violet and blue on the window frame, with daylight in between.

In testing the screens, it is better to have two or three of each colour, so that the best set of three can be selected. When the prism is focussed upon the window, and a perfect spectrum seen, place the red screen in front of the prism. The colours from the violet to nearly the end of the

green should entirely vanish, and appear black. If this is so, the screen may be passed as being approximately correct. The green screen should be found to shut out all the violet, about half the blue, and nearly all the red, while the blue screen should pass all colours from the violet end to nearly the end of the green, a very deep band of ruby appearing at the red end.

If a coloured chart of the spectrum be at hand when testing, the work will be easier, as the lines given in the coloured representation will take the place of those absent in the real spectrum we are using in the window. This will be found a very satisfactory and inexpensive method of proving our colour screens. This set is, of course, intended to be used with a Cadett "Spectrum" or a Lumière "Panchromatic" plate. They may be placed either in front or behind the lens, but the best place is behind, and any one at all handy with a plane, chisel, and fret-saw could easily make a camera front attachment containing a receptacle for the screen.

The individual exposures with the three filters must be found by experiment. For a first trial upon a floral subject at $f/16$, by window, summer light, six, forty, and sixty seconds for the blue-violet, green, and red negatives respectively might be tried. The key to success in colour work is,

given fairly correct screens, to get three properly exposed negatives all equally developed, and to facilitate this it is preferable to develop the three plates together in the same dish. No tricks to correct exposure during development are permissible. A normal pyro-soda solution, without bromide, should be used, and if exposures and development have been correct, any perfectly white object in the picture will appear with equal density in each negative.

Great care must be taken to guard against fog, both when placing the plates in the dark slides and during development. It is impossible to use the ordinary dark-room lamp, but a piece of glass, cut to any size, and known as a "safe light," may be obtained from Messrs. Cadett and Neall, Ashtead, Surrey, which can be placed in the lamp in lieu of the ruby glass; or, as a substitute, we may place our ruby lamp in a box, one side of which has been glazed with ruby and blue sheet glass, procurable for a few pence at any glazier's. When the three glasses are laid one upon the other, the colour should, on looking through them, not be paler than the combined colours of our red and blue-violet light-filters, which will appear a deep ruby when viewed in a similar manner, but rather deeper for preference.

We now arrive at the second method of making

our negatives, that is, by using the three different brands of plates previously mentioned. The screens in this case are a pale ruby, orange or aurantia, and violet, and are easier to make, requiring only one film upon one piece of glass. I can fancy I hear some one asking why the screens in this case are of a different colour from those previously described. Why should not the red, green, and blue set be used? Well, in truth they could, but it is not necessary. When using a plate sensitive to the whole length of the solar spectrum, a green filter is used for the green sensation negative because it passes the colours which are required to be recorded in the negative, and stops all others. Lumière's A plate being comparatively insensitive to red, there is no object in using a screen that absorbs this colour, and an aurantia filter, which gives a good rendering of the greens and yellows, while suppressing the blues and violets, is quite sufficient.

In the opinion of the writer this way of working is preferable to all others for amateur use, there being a greater chance of successful results being obtained by novices than would be the case were a start made with "Spectrum" or "Panchromatic" plates, unless, of course, the screens or a special camera be commercially procured. Beginners are, therefore, counselled by the author to closely

adhere to the instructions contained in the rest of this chapter.

Thin lantern plates, which have been soaked in hyposulphite of soda, to dissolve the silver bromide, and thoroughly washed, are coloured in the following dye baths:—

Ruby.

Judson's scarlet ...	...	...	1 penny packet.
Hot water	...	...	1 oz.

Aurantia.

Judson's yellow (penny packet)	6 gr.
Hot water	1 oz.
"Diamond" orange (for silk and wool)	3 gr.
Hot water	1 oz.

Violet.

Judson's violet ...	...	1 penny packet.
Hot water	...	1 oz.

The aurantia colour is obtained by immersing alternately in the orange and yellow baths. Occasionally the violet solution may be found to stain the gelatine film unevenly. In this case, clean off the gelatine and coat the glass with collodion. The red and violet screens should be stained as deep as the baths will colour them; but the aurantia filter should be withdrawn when it appears to be of a tint somewhat similar to that of a

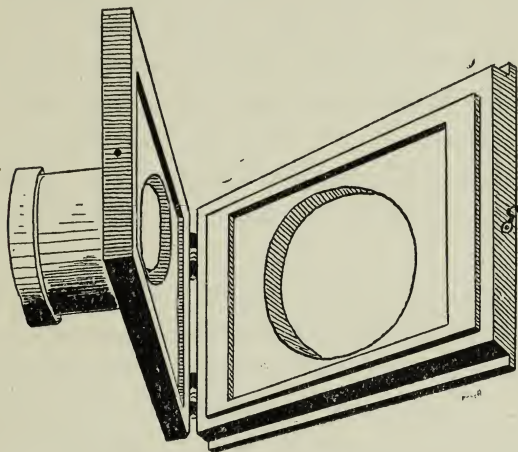
deep screen used for ordinary isochromatic work. Success in staining the gelatine films depends to a great extent upon having the dye thoroughly dissolved and using the solutions as warm as the gelatine will bear it without frilling. The commercial dyes mentioned for screen work are those which the author has found best adapted to the purpose. In some towns it may happen that one particular brand only can be obtained, and as some colours are not suitable for staining gelatine, disappointment may result. As a general rule, dyes sold for woollen goods answer best with gelatine, and special cotton colours with collodion; but there are exceptions, and some dyes will colour both. Judson's or the "Diamond" brands should, however, be purchased whenever possible.

The screens must be slightly rinsed after staining, and set up to dry, when they can be cut up with a shilling wheel glass-cutter to any desired size, except in the case of the violet screen, using collodion, when the glass should be cut before coating, as the film is too tender to bear rough usage.

My own screens are cut to fit a special camera front. It has a hinged door carrying the lens, and works well in practice. The illustration given should enable any one to copy it. It is

made of quarter-inch cedar, and the screens are inserted in turn when making the negatives.

The negatives from which the prints given on pages 10 and 11 are made were produced in this way. The violet screen was used with an Ilford ordinary, and the exposure at 11 a.m. on a bright July



day, by window (south light), stop $f/16$, was four seconds. The orange screen, which should be about the shade of a deep screen used for ordinary isochromatic work, was used with a Lumière A plate under the same conditions, giving thirty seconds' exposure, the red screen being utilised with a Lumière B, same stop and light, the exposure being one minute, all three plates being developed

with Lumière's pyro-soda formula. In developing the latter plate, do not omit to put a piece of green sheet glass in place of the red in the dark-room lamp, and it is better rather to lay a second piece of green in front of the lantern to make doubly certain against fog.

When photographing flowers, be careful to see that all stalks are well in the water, or leaves may be found to have drooped considerably before the third plate is exposed. This happened to a slight extent in the case of those depicted in the subject illustrating Chapter II. Such an accident is fatal to accurate registration in printing.

There is yet another way of making our screens, namely, by dyeing negative plates which have had the silver bromide dissolved out, as with the lantern plates. These have an additional advantage, in that they can be placed in the dark slide in front of the plates, film to film, so that no cutting or special camera front is required. The exposures and manipulations are the same as given for those made upon the lantern plates, but if desired, the exposure for the blue-violet negative on the Ilford ordinary may be made *without* a screen, its place in the dark slide being filled by a piece of clear glass. Many experts are of opinion that the use of a violet screen with an ordinary plate has no

effect other than to increase the exposure ; still, personally, I prefer to use one. The ground glass of the camera must be reversed to allow for the displacement of the plates by the extra thickness of glass in the dark slides.

This method of working is simplicity itself, and I can recommend it for experimental work.

CHAPTER IV.

PRINTING ON PAPER.

HAVING obtained our negatives, the question of printing on paper arises, and to accomplish this we must superimpose three prints in the primary colours of the artist upon one piece of paper. As a matter of fact, colour photographs on paper are as plentiful as blackberries in the autumn. They are seen every day of the week by thousands of people, though they are not generally recognised as such by the public ; of course I allude to the three-colour illustrations in the weekly and monthly papers and magazines. Perhaps I should be more correct in calling them reproductions from colour photographs. Every one is readily able to recognise an ordinary photograph when they see one reproduced in the pages of *The Amateur Photographer*. These letterpress illustrations are made from photographic prints by means of half-tone engravings on copper, which can be printed from in ink of any colour. Colour prints are produced in just the same way, only, of course, there

are three photographs to be copied instead of one, and therefore three half-tone blocks to be used, one being printed from in yellow ink, another in cyan-blue, and the third in magenta-pink ink, each print being made to register one upon the other.

Unfortunately, life is too short, and money too scarce, for amateurs to make their prints in this way, and a cheaper and less elaborate process has to be resorted to.

The simplest method, and the one best adapted to amateur use, is to take a piece of commercial ferro-prussiate paper, such as that sold by Marion and Co., and make a print upon it from the red sensation negative. This is not absolutely the correct shade of blue, but it is as near as we can get to it photographically. The colour should, as a matter of fact, be a cyan-blue, the complementary to the fundamental red of the solar spectrum—that is to say, the colour which, in the form of light, would, if mixed with the fundamental red, produce white.

We next should make a print in lemon-yellow in perfect registration upon the ferro-prussiate positive. This is most nearly approached by printing in the gum-bichromate process with yellow-lake. The blue print is immersed for one or two minutes in a ten per cent. solution of bichromate of potash, and hung up to dry in the dark; or this operation may be hastened by holding in

front of a gas flame. When perfectly dry, we may coat the print with the gum and pigment. The gum solution is made up by dissolving half an ounce of the finest gum acacia in three ounces of hot water. A little of this is poured out when cold upon a porcelain palette—the back of a bromide opal makes a capital substitute. About one dram will suffice to coat a quarter-plate print, and to this quantity add just sufficient yellow-lake to colour the gum, the whole being thoroughly mixed with the blade of a knife—an artist's palette knife for preference. The pigments used are those sold by artists' colourmen in twopenny tubes for water-colour drawing. Spread the mixture upon the paper with a round camel-hair brush, commonly called a mop, evening up and smoothing the coating with a badger-hair softener, and dry in the dark.

The blue picture is easily seen through the coating of gum and yellow-lake, as this pigment is very transparent, so that the print is readily adjusted in the printing-frame in accurate registration under the blue-violet negative from which we are about to print.

The exposure must be found by experience, so much depending upon the nature of the light and the thickness of the coating ; but, as a rough guide, it may be mentioned that this will be far less

than is the case when making an ordinary print by this process, using an opaque pigment.

It is best to lay the print face down upon a dish of tepid water to develop, which should automatically take place in about half an hour, or less if under-exposed. If development takes place too slowly, and over-exposure is suspected, raise the temperature of the water. On no account attempt any of the tricks resorted to by monochrome workers, such as local brushing away of pigment, etc. Allow the print to develop itself, or the colours in the resulting print will be in correct. If any assistance is required, a stream of water may be allowed to flow very gently across the surface of the picture. When sufficiently developed, immerse in a ten per cent. solution of alum, to harden the gum and expel all traces of the yellow bichromate of potash, and in this solution the print must remain until all yellowness in the whites has disappeared.

When dry, we resensitise in the bichromate bath as before, dry in the dark, and coat again with gum and pigment, this time using crimson-lake for the colouring matter. This colour is very near the complementary to the fundamental green, and in printing with it we, of course, use the green sensation negative. After development, which is carried out in precisely the same manner as with

the yellow print, the picture should be, approximately, a facsimile in colour of the original subject photographed. It is possible, however, that we may have made the blue print too dark, or the yellow too pale, and so on, in which case the print may not be worth keeping, and another must be made.

Owing to the extreme transparency of yellow-lake, it may sometimes happen that, after development, the greens and yellows may appear rather weak. In this case, make a second printing in yellow-lake before commencing the crimson. Another disadvantage possessed by this pigment is its lack of permanence. This difficulty may be overcome by dispensing with it altogether, and substituting a more permanent, though opaque, yellow. I have used chrome-yellow No. 2 with advantage. It might be supposed that this colour would be too bright, seeing that lemon, or primrose, yellow is the complementary to the primary blue-violet. It, however, loses much of its brilliancy after passing through the gum-bichromate process. Aureolin is another substitute for yellow-lake. It is transparent and quite permanent, but, unfortunately, very expensive, and extravagant in use.

In working with chrome-yellow it will be necessary to print from the blue-violet negative

first upon well-sized paper, and no better for the purpose can be found than that sold by the Autotype Company for carbon work, under the title of "Matt Surface Single Transfer," especially for large work. It must first be sensitised in the bichromate bath, and dried, then coated in the same way as with yellow-lake; but as chrome-yellow is as opaque as a brick wall, we shall not require to mix so much pigment with the gum. When developed and dried, sensitise the yellow print for the blue impression as follows:—Dissolve sixty grains of ammonio-citrate of iron in one ounce of water, and fifty grains of potassium ferricyanide in another ounce of water. For use, mix in equal parts. One dram of each will suffice to coat several quarter-plate prints. The solution should be brushed over the yellow print sparingly with a camel-hair mop, the coating being evened up with the badger softener, and dried as soon as possible. After printing, develop in the manner common to the ferro-prussiate process, namely, by soaking in cold water. When complete, make the third printing in crimson-lake by the gum-bichromate process.

I have not considered it necessary to enter into the theory of gum-bichromate printing, as most readers of this little book are doubtless familiar with it. If not, *The Amateur Photographer* hand-

*Am Cit 60 gr
Pot Ferri 50 gr
Water 1 dram
Dissolve in 2 oz*

book entitled "Photo-Aquatint," by A. Maskell and R. Demachy, and published at 1, Creed Lane, E.C., might be usefully consulted. Still, if the instructions given here are closely followed, the process will explain itself.

In printing in the manner just described, it is advisable to use duplicate negatives, and these might just as well be enlarged while we are about it. The reason for this is that in shifting the prints about in the printing-frame to receive registration, the negative films are liable to get rubbed, and so spoil them for lantern slide work.

This objection could, however, be overcome by utilising the carbon process, and it is a matter of surprise to the writer that materials have not ere this been placed upon the market. In case any wealthy amateur is disposed to place a special order for his own use, and as an inducement to some enterprising firm to fill a long-felt want, I will suggest the following process:—The materials required are bands of tissue made of the same pigments as used at the present time in the manufacture of printing inks for commercial tri-chromatic work, sheets of transparent celluloid, matt-surfaced opal or specially prepared waterproof paper coated with hard gelatine.

To make a print, a piece of each of the three tissues is cut to the required size, sensitised in the

bichromate of potash solution for three minutes, and squeegeed immediately after removing from the sensitising bath upon separate pieces of the transparent celluloid, which must be thoroughly waxed or rubbed with French chalk on the side brought into contact with the tissue, and allowed to dry in the dark. The three tissues are placed behind their respective negatives to print with the celluloid surface in contact with the negative film, developed from the back, as in ordinary carbon printing, and the pictures allowed to dry upon their temporary celluloid supports. Nothing now remains but to transfer the three prints to opal, or a piece of the waterproof paper, in the following manner:—Soak a piece of the paper in cold water to soften the gelatine, and bring into contact with the yellow print, squeegee, and, when dry, strip off in the usual way from temporary support. Now immerse, face upwards, in a dish containing ten ounces of a five per cent. solution of Nelson's No. 1 gelatine, into which one ounce of a ten-grain solution of chrome alum has been stirred whilst warm. This must be kept in a warm liquid state while in use. Bring the blue print into contact underneath the surface of the gelatine solution, and carefully work into registration with the print in yellow. Lift both out together, see that the registration is perfect, squeegee lightly, and set up to dry, when strip.

Repeat the operation to transfer the crimson print.

This should prove a simple and inexpensive method of printing in colours upon paper. One great advantage it would possess over the gum-bichromate process lies in the fact that the result could be viewed before finally transferring in superposition, as the prints, being upon temporary supports of transparent celluloid, could be laid one upon another on a piece of white paper. If one was found a little too pale in colour, or another too deep, a fresh print could be made, and the triple transfer made only when we were satisfied with the final result, whereas in the gum-bichromate method it is not until the third and last print is superimposed and developed that we know if our print is to be a success or not. Registration, too, would present little difficulty, owing to the fact that the prints could be viewed through the back of their transparent supports during transfer, while unequal expansion of the three prints would be almost an impossibility. I venture to think that materials for such a process, together with a set of light-filters, would form a practical outfit wherewith to make colour photographs on paper with a minimum of trouble.

CHAPTER V.

LANTERN SLIDES

As with paper prints, to produce transparencies for the lantern it is necessary to superimpose three prints from our three negatives in the primary colours of the artist. Various methods of arriving at this end have from time to time been prominently before the photographic world, notably those of J. Wallace Bennetto, Dr. Sellé, and Messrs. Lumière. The former worker has occasionally shown examples in London which are understood to have been made by the carbon pigment process. In the methods adopted by Dr. Sellé, and Messrs. Lumière, the results are obtained by superimposing three films stained with dyes. The transparencies produced by the latter are procurable, for either the lantern or stereoscope, from Messrs L. Gaumont & Co., 25, Cecil Court, Charing Cross Road, London, W.C., and as examples of the capabilities of three-colour photography are difficult to surpass.

The best and easiest process for amateur workers

is to first of all make an ordinary lantern transparency from the red negative upon an Ilford "Special" or an "Alpha" plate. With the former the slide should be kept thin, but with the latter the transparency should be of full depth—in fact, made as though it were intended to be shown as a single slide with limelight, and it is immaterial whether the tone is a greenish black or a warm brown. Personally, I prefer the "Alpha" plate, on account of its transparency and brilliancy.

After developing, fixing, and washing, in the usual way, the slide should be allowed to get thoroughly dry when it is immersed in a ten per cent. solution of ferricyanide of potassium until thoroughly bleached, washed in running water for ten minutes, and placed in a five per cent. solution of ferric chloride, when the colour of the image will change to a blue. After a slight washing the slide may be set up to dry.

The transparencies from the red and green negatives are made upon thin clear celluloid coated with soluble silver bromide emulsion. Films suitable for this purpose can be obtained from Messrs. Fitch & Co., Seldon House, Fulwood's Rents, High Holborn, London, W.C., and when ordering, the purpose for which they are required should be distinctly stated.

The films are sensitised by soaking for three

minutes in a one per cent. solution of bichromate of potash, and placed in an upright position to dry in the dark. I find a band-box very convenient, as the films can be placed around the inside, leaning against the sides, and the lid closed to keep out the light and dust. On no account lay them down flat to dry, as the surplus bichromate solution would be unable to drain off, and would probably crystallise upon the film. When dry, clean the celluloid surface with a piece of silk or chamois leather.

To print, a piece of the sensitised film is placed with the celluloid surface in contact with the negative and exposed to daylight, the time required being about three minutes on a cloudy summer's day. Printing is easily watched, as the image shows up in grey upon the pale yellow film. When the picture is distinctly visible on the gelatine surface—that is to say, the back of the film as we are using it—it is placed in warm water to develop, just as though it were a carbon print, only, of course, there is no support to strip off.

It is best to begin development at a temperature of about 60° Fahr., increasing to 90° or 100° Fahr. if necessary. Great care must be exercised to avoid touching the gelatine side of the film with the fingers, as it is very tender during the process

of development. It may, however, be held at one corner by the first finger and thumb, and kept gently moving in order to assist the washing away of the soluble emulsion. When development is complete, place in clean cold water for ten minutes to set the gelatine, and transfer to a bath of hyposulphite of soda—two ounces to the pint of water. When all the silver bromide has dissolved, wash in gently running water for about half an hour.

We have now a print in transparent gelatine upon a support of equally transparent celluloid, and it only requires the gelatine picture to be coloured the requisite tint to complete it.

The positive from the green negative is placed in a bath of Judson's magenta dye (a penny packet to the ounce of hot water), the print from the blue-violet negative being immersed in a solution of Judson's yellow (a penny packet), six grains to the ounce of warm water. These solutions should be freshly prepared, and used at a temperature of about 40° or 50° Fahr. When the films are stained a deep enough colour, they should be rinsed for a few seconds in clean cold water to remove the superfluous dye, and set up out of the dust to dry.

It is a good plan to make two or three transparencies from each negative, in order that the

set which is found to give the most truthful and pleasing colouring when superimposed may be used, though of course the stained films can be modified to a certain extent. For instance, should the pink transparency be a trifle too deep, it may be reduced in colour by a short rinse under the tap, while on the other hand, if too pale in colour, a few seconds in the dye bath may set matters right.

As with monochrome work, results from the same negatives will vary considerably, owing to over- and under-exposure or development, which will upset the colouring a great deal, and it is, therefore, just as well to make two or three extra positives while we are about it.

When the best set of three has been selected, they may be cemented together with Canada balsam. It is, however, very sticky and messy stuff to work with, and, moreover, dries very slowly. For these reasons it will be found safer to use Higgins's photo-mounter applied to the edges of the films and glass. When all three transparencies are superimposed in perfect registration, bind up in the usual way with a lantern slide cover glass. This will be found a very easy way of making lantern slides in colour, pleasant to work, and giving the best of results. The materials are simple, inexpensive, and easily procurable.

With such a simple process ready to hand it would appear superfluous to describe other methods. Still, Mr. F. E. Ives, who has done more than any one to put colour photography upon a sound practical basis, has attained similar results, using ordinary films sold for negative work, such as Eastman's, etc. I have tried these films as at present made, but they appear to be insufficiently soluble for the work. The "Wellington" paper negative film, however, is admirably adapted to slide-making, and as easy to work as carbon tissue.

The film should be cut in pieces three inches square and sensitised in the following bath:—

Bichromate of potash ...	...	...	2 dr.
Water ...	...	...	5 oz.
Liquid Ammonia '880 ...	...	...	5 min.

It should remain in this solution for three minutes, and then be squeegeed down upon thin clear celluloid, and allowed to dry under pressure. Printing is performed in the same way as with the ready-coated material previously described, only the negative must have an opaque paper mask pasted upon the glass side, leaving an opening about two and three-quarter inches square, to provide a "safe edge" in order that the paper support may be stripped off to develop the image, as in ordinary carbon printing. The blue positive

is made upon an Ilford lantern plate as before ; but the yellow transparency may be made upon the cover glass. In this case a piece of the "Wellington" film is sensitised in the bichromate bath for three minutes, and squeegeed upon a piece of clean plate glass to expel the surplus solution. It must be lifted off the glass as soon as possible, and placed in the dark to dry. Printing is conducted before the film is transferred to its final support—namely, the cover glass. When sufficiently printed, *float* upon clean cold water to soften the gelatine, squeegee down upon the cover glass, and place under pressure for twenty minutes before commencing to develop. Be careful not to wet the paper support more than can be avoided or the film will expand, and consequently fail to register with the other two transparencies. The same dye baths are, of course, used.

It is an excellent plan to combine the two methods by making the pink and blue transparencies in the manner described earlier in this chapter, and the yellow upon a lantern cover glass, using the "Wellington" film.

The yellow transparency, when made upon glass, should be finished first, in order that it may be used as a guide in making the blue positive, the idea being to get the two pictures to occupy similar positions upon the respective glasses, so

that the edges of both may coincide when finally bound up. In this way we have only one celluloid film, which carries the pink transparency, sandwiched in between the Ilford slide (blue transparency) and the cover glass supporting the yellow picture.

In addition to the methods above described, a complete printing outfit for trichromatic lantern-slides is sold by Messrs. Sanger Shepherd & Co.

CHAPTER VI.

THE JOLY-McDONOUGH PROCESS.

THOUGH a three-colour process, this method requires only one negative, from which a single lantern transparency is printed upon an ordinary lantern plate. It is remarkable for its extreme simplicity, requiring, as it does, no special apparatus beyond the screens, which are sent out in two varieties, one for taking the negative, the other for use as a cover glass for the lantern slide. The latter screen, when held to the light, appears quite colourless; but in reality it is ruled with alternate transparent lines of red, green, and blue-violet. They are, however, so fine that it is impossible to distinguish them with the naked eye, and they all blend together, forming a white light, because, as before explained, these are the three primary colours of which white light is composed.

The negative, or taking, screen is ruled in a similar way, but, for the same reasons that different screens are used for taking the negatives and viewing the positives in the three-negative

process, the colours are slightly different. It is placed in the dark slide of the camera, with the ruled surface in contact with the film of a Cadett "Spectrum" plate, a yellow, or orthochromatic, screen being inserted in the lens to equalise the exposure required for the different coloured lines. In this way it performs the work of the three screens, which are used when three separate negatives are made—that is to say, one line passes those colours required to be recorded in the red sensation negative, the next passing those for the green, while the third looks after the blue-violet; so that we have, as it were, three negatives of varying densities, not on three plates, but upon one plate, huddled together, so to speak, in very fine strips, side by side, but not overlapping; first a slice off the red, then a cut off the green, and next a strip off the blue-violet, commencing again with another piece off the red, another bit off the green, and so on in the same order right across the plate.

The lantern slide, which is made from this negative by contact, is, obviously, also made up of lines of unequal densities, and the viewing screen is bound up in contact with it, film to film, so that the red lines fall upon those representing the red sensation positive, the green on the green, and the blue-violet upon those comprising the

blue-violet positive, when the original colours will be found to appear with great fidelity.

The reason for this is easily explained. Supposing, for example, our positive depicted some scarlet geraniums and yellow calceolaria, the space occupied by the geraniums in the monochrome slide would be made up of alternate lines in sets of three, the first nearly clear glass, the next two being nearly opaque. In the parts representing the yellow calceolaria they would alternate thus—first two clear, and the third opaque, and so on, each set of three lines recurring in the same order. When the ruled screen is bound up in position, the geraniums will appear red because the green and blue-violet lines are stopped out by the opaque lines in the positive monochrome transparency. The calceolaria will be yellow because the blue-violet lines are stopped out, leaving only the red and green lines, and we know that red and green lights blended produce yellow. Were the violet lines left in, the calceolaria would be white.

Let me here mention that, although we are dealing with positive colour transparencies that are viewed by transmitted light, we are not superimposing any colours, but are obtaining our results by the blending of coloured lights, hence the reason for ruling the viewing screen in the primary, or fundamental, colours of the solar spectrum.

It might be supposed that the result would look rather coarse and the ruling conspicuous, but such is not the case. The lines are so extremely fine that when the picture is viewed at a distance of eighteen, or more, inches with the naked eye, they entirely disappear. The slides can be thrown upon the screen by an ordinary single lantern, and if they are not shown too large, and not viewed too close, and thrown just a trifle out of focus, the effect is charming in the extreme. The process is admirably adapted for still life subjects, such as flowers, fruit, bric-à-brac, natural history specimens, etc., and, as far as colouring is concerned, is difficult to surpass. Moreover, its simplicity renders the proportion of failures very small. Of course, it is not necessary to have a separate viewing screen for each slide. Two will suffice to show any number of pictures, as, while one screen is in the lantern, the other can be fitted to another slide, and fastened with clips.

The necessary materials are being placed upon the market by the Colour Photo Co., Birkbeck Bank Chambers, Southampton Buildings, Holborn, London, W.C.

CHAPTER VII.

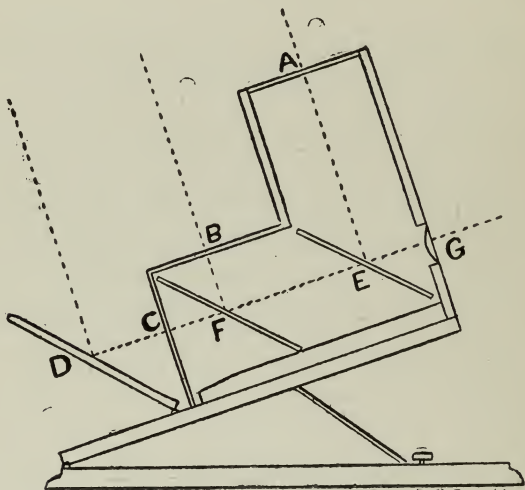
THE "KRÖMSKÖP"—THE "KROMAZ"—THE "MELANOCHROMOSCOPE."

THE "KRÖMSKÖP."

THIS instrument, devised by Mr. F. E. Ives, is supplied commercially by the Photochromoscope Syndicate, 28, The Pavement, Clapham Common, S.W., for the purpose of viewing small transparencies by blending the primary colours of the solar spectrum—namely, red, green and blue-violet.

The accompanying diagram will explain the manner in which the three lights are combined. At A, B, and C respectively are red, blue-violet, and green glasses, corresponding to the primary spectrum colours. To produce a white light the instrument is inclined to the sky in such a position that the three coloured glasses receive equal illumination, the red and blue by direct light from the sky, and the green by reflected light from the silvered mirror D.

E and F are *transparent* reflectors, or mirrors, placed at an angle of forty-five degrees to the red and blue glasses respectively. Every one knows that when an object is held, say, two feet in front of a domestic looking-glass, it will appear to occupy



The "Krömsköp."

an equal distance behind it. In the "Krömsköp" the reflectors E and F are equidistant from the coloured glasses A C and B C respectively. Therefore it must be plain to all that upon looking through the magnifying lens at G, which is focussed upon C, we shall see the red and blue glasses in addition to the green, or, to be more

explicit, no colour at all, provided, of course, that the three glasses be equally illuminated.

When the monochrome transparencies, which are mounted upon a hinged cardboard frame and placed respectively in contact with the red, green, and blue-violet glasses, are made, upon looking through the eyepiece at G, to register as one picture at C, the colours of the object photographed will appear.

The best results, so far as colouring is concerned, appear to be obtained when the apparatus is pointed at an evenly lighted pale grey sky. In summer weather, when blue skies and white clouds predominate, it is necessary to place a piece of ground glass over the instrument in order to diffuse the light, and secure even illumination of the three coloured glasses. For use in the evening, and upon dark days, a special Welsbach incandescent gas lamp may be used.

The instrument is procurable in either stereoscopic or monocular form, the latter being known as the "Junior Krömsköp," and intended for use in conjunction with the special camera back mentioned in Chapter III.

The "Lantern Krömsköp" is an attachment for use with an ordinary single lantern, and is, in fact, a miniature triple lantern, in which the three lenses are arranged side by side. By means of

a simple arrangement of transparent reflectors, the light from one lime is made to simultaneously illuminate three small condensers, in front of which are placed the three positives, which are projected upon the screen through their respective colour screens. The best and largest results are obtained with an electric arc lamp, though a mixed limelight jet will show good pictures on a small scale.

There is yet another piece of apparatus, recently designed by the same inventor, called the "Miniature Photochromoscope," which, to judge from the descriptions published, should become extensively used. Unlike the other patterns, the three positives are viewed as one picture in colours while they remain, side by side, upon a single plate.

The following is a description of the instrument given by Mr. Ives in a lecture delivered before the Photographic Society of Philadelphia :—

"The 'Miniature Photochromoscope' is the name given to an instrument which is smaller and simpler in construction and less costly than the 'Junior Photochromoscope,' and takes a picture which is also cheaper, because it is made on a single piece of glass. The 'Miniature Photochromoscope' shows a small picture as perfectly as the 'Junior' shows a larger one, the apparent area being about as one is to four.

"In order to blend and register three images which are on one plate without considerable complication of apparatus, the positive images are inclined to the axis of vision, and the consequent foreshortening and distortion of the image is corrected by a new prism lens combination worked out expressly for this purpose. This combination not only corrects the foreshortening and distortion, but at the same time focusses and magnifies the image, which is sharp and clear from centre to edge.

"The 'Miniature Photochromoscope' can be used at a window, like the 'Stereo' and 'Junior' patterns, and is adapted for artificial illumination by means of an attachment carrying a convex lens, in front of which, at a distance of twelve inches, is placed a suitable source of light, preferably a Welsbach incandescent gas light, with a special white mantle, which is now made to order for such purposes. Under these conditions the illumination of the image is most brilliant. Photographs for the 'Miniature Photochromoscope' can be made on $2\frac{3}{8}$ in. $\times$ $6\frac{1}{2}$ in. plates, with a special 'multiple back' (one plate, three exposure) camera, and pictures made in the regular photochromoscope cameras can be used in it by mounting them to register on a cardboard frame."

The negatives from which the positives are

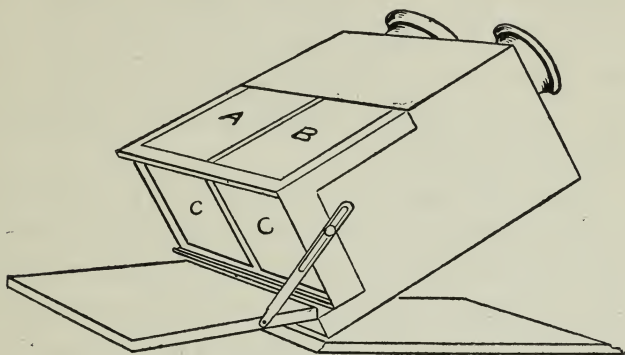
printed are also made upon a single plate, side by side, and at one exposure, in a new camera of such simple construction that it "can safely be placed in the hands even of 'button-pressers,' and is no more liable to get out of order than a 'Kodak.' "

At the moment of writing this chapter no further particulars of this camera, or of the "Miniature Photochromoscope," are available. In all probability they will be introduced on this side of the "herring pond" at the third Traill-Taylor Memorial Lecture, entitled "The Optics of Trichromatic Photography," which will be delivered by Mr. Ives in November of this year.

THE "KROMAZ."

This is a stereoscopic viewing instrument designed by Messrs. Barnard and Gowenlock, and is of somewhat similar construction to the "Krömsköp," though it can only be made in stereoscopic form. It has, however, no upper story, the red positive being placed by the side of the blue-violet upon the top of the apparatus at A and B, whilst two green positives are put in position at the back C, and in this way satisfactory results are secured. In all other respects it resembles Mr. Ives's "Krömsköp," and is used in precisely the same manner.

In practice, two pairs of stereoscopic negatives are utilised for printing the positives—namely, the green, and opposite halves of the red and blue-violet pairs. A special camera attachment



The "Kromaz."

for making the negatives completes the outfit, which may be purchased from Messrs. Watson and Sons, 313, High Holborn, London.

THE "MELANOCHROMOSCOPE."

The "Melanochromosome" is a combined camera for taking the three negatives upon one plate at one exposure, and viewing the transparencies in colours. It has been designed by Ducos du Hauron, exhibited at the Paris Exhibition, and will be placed upon the market by MM. L. Lesuer and Ducos du Hauron, 22 Rue Rambuteau, Paris. It

is said to give excellent results ; but as the three negatives are made upon one plate $4\frac{1}{2} \times 13$ cm., or about $5\frac{1}{4} \times 1\frac{3}{4}$ inches, the apparatus almost constitutes a process in itself, as the size of the negatives must of necessity, without recourse to enlargement, preclude their being of any real use for printing on paper or making lantern slides, and this remark applies equally to the "Miniature Photochromoscope."

Still, with those who have neither the time nor inclination to make transparencies and paper prints, and desire to produce pictures in colours with the least possible trouble, these instruments should become exceedingly popular. Another point in their favour, as far as amateurs are concerned, and apart from the easy manner in which the three negatives are secured, lies in the fact that the colours obtained with viewing instruments are nearly always finer and truer to Nature than are paper positives.

CHAPTER VIII.

CONCLUSION.

IN bringing these chapters to a close, I trust that those of my readers who have carefully studied their contents will have been sufficiently initiated into the mysteries of colour photography to realise that, after all, it is not such a difficult matter to produce pictures in colours as the majority of photographers are prone to imagine, neither need the work be more costly than ordinary monochrome photography. Doubtless it may be a saving of time to purchase the necessary apparatus from the supplies commercially available, yet it is not the happy lot of every amateur to be able to lay out a ten-pound note upon special cameras and appurtenances, and I have, therefore, endeavoured, and I hope successfully, to show that there is nothing required in connection with the process, be it apparatus or working materials, which cannot be easily made at home, or procured at trifling cost.

Every method of making the colour screens, of

printing on paper, and producing lantern slides, described in this treatise is based upon the practical experience of the writer, and, if carefully carried out, results equal in every respect to those obtained with more expensive apparatus should be readily secured.

In conclusion, I trust this little book may be the means of inducing many others to take up three-colour photography in one form or another. The difficulties, if any there be, are easily overcome with a little practice and patience, and when once a fair start has been made, and the subject thoroughly grasped, there are but few, I think, who will have any desire to abandon the work.

THORNTON-PICKARD

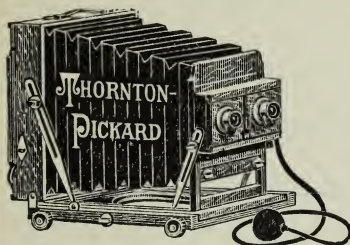
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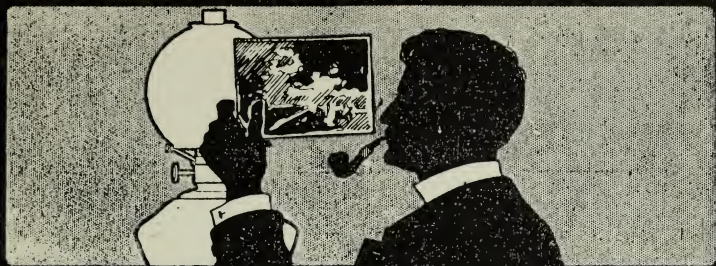
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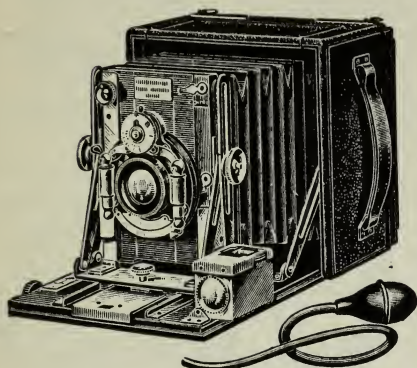
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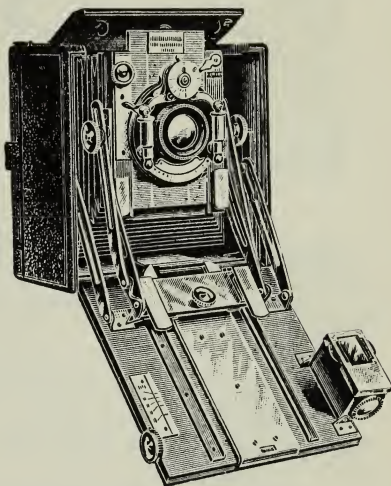
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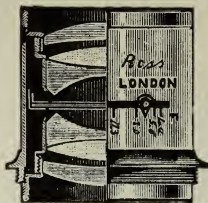
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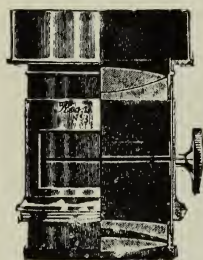
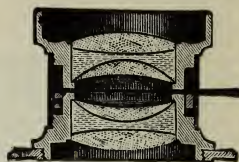
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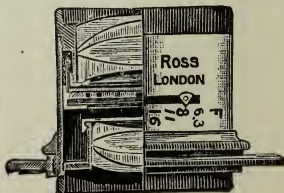
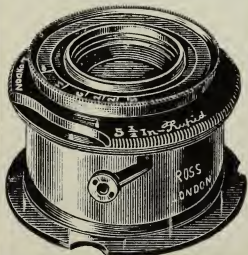
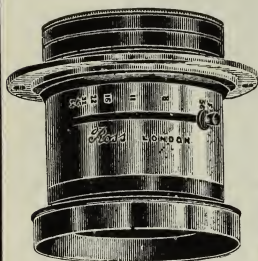
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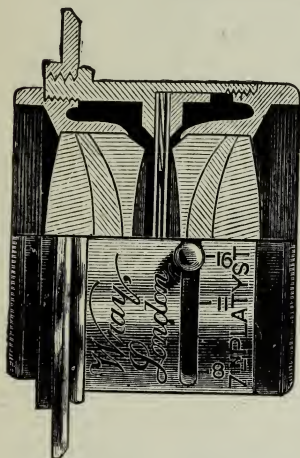
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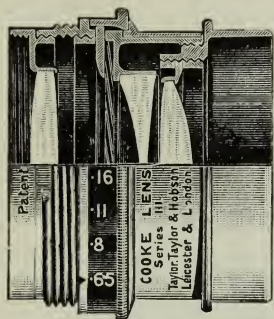
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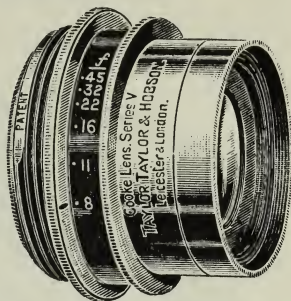
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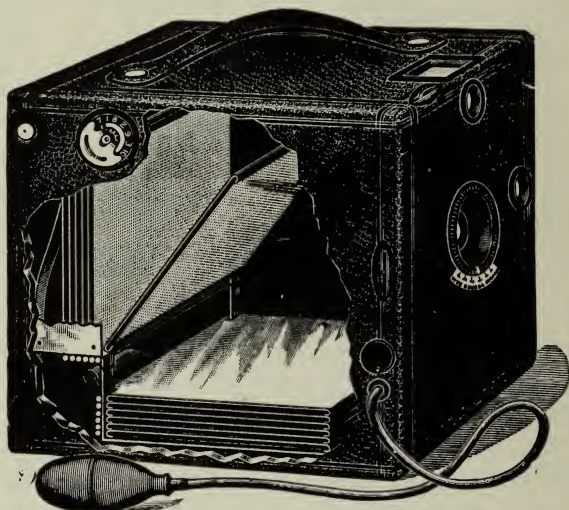
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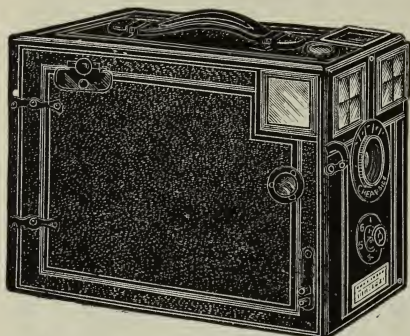
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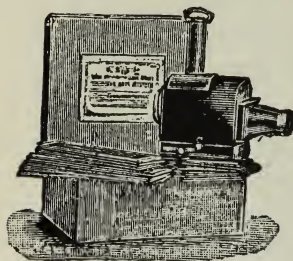
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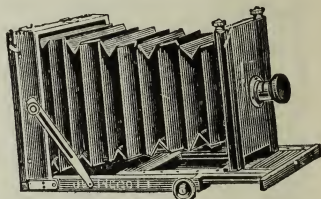
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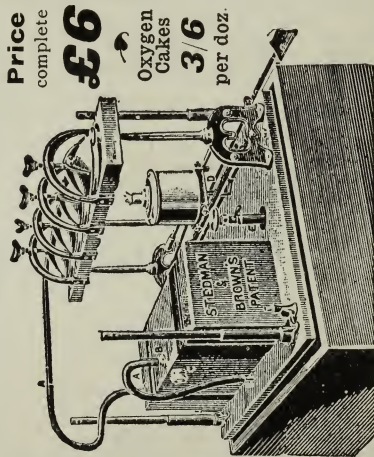
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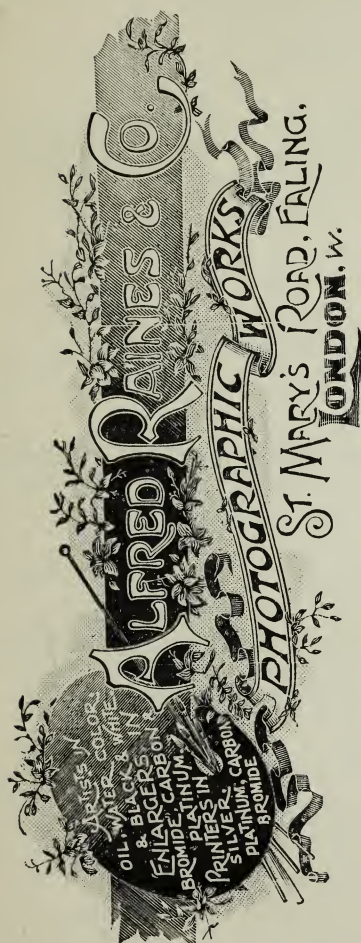
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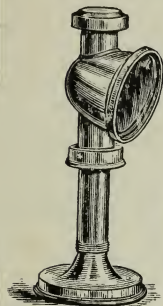
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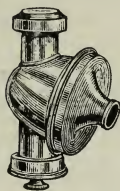
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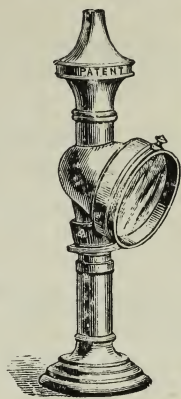
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